

**OCR**  
**A Level**  
Computer  
Science  
H446 – Paper 1



**Thinking  
abstractly**

Unit 10  
Computational  
thinking



**PG ONLINE**

# Objectives

- Understand the nature of and need for abstraction
- Describe the differences between an abstraction and reality
- Devise an abstract model for a variety of situations

# What is computational thinking?

Computational thinking is simply working out how to work things out, or:

‘The ability to think logically about a problem and apply techniques for solving it’

- It is closely related to the skill of designing algorithms which can be turned into computer programs





# Computational thinking

*“Computational thinking involves solving problems, designing systems, and understanding human behaviour, by drawing on the concepts fundamental to computer science.”*

***Jeannette M Wing***

*Vice President, Head of Microsoft Research International*



# Computer Science

- ...is about using mathematical principles to solve problems
- ...is not about how to use a spreadsheet, a word processor or a graphics package
- ...involves learning to think computationally
- ... and applying the principles of **abstraction**



# Computational thinking

- What information is relevant to solving a particular problem?
- What computations need to be performed in order to solve the problem?
- How can we be sure that the problem has been solved?

# What is abstraction?

- Abstraction is a way of separating the logical and physical aspects of a problem
- If you are learning to drive a car, you concentrate on the function of the steering wheel, accelerator, brakes and so on
- If you are learning to be a mechanic, you will concentrate on how these things actually work



# Thinking abstractly

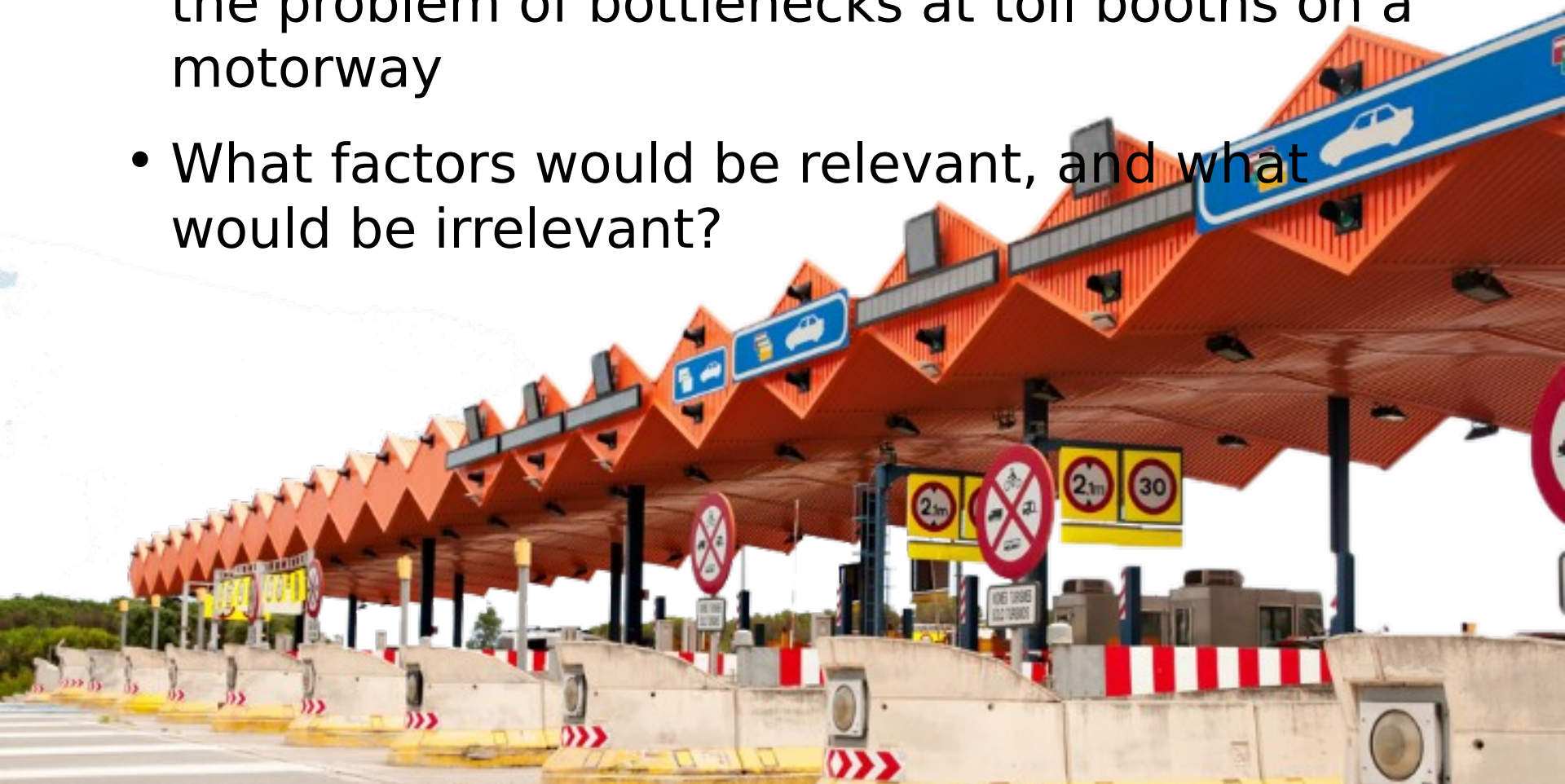
- Abstraction typically involves:
  - devising a model that represents the reality – for example, think of a simple queue, or something as complex as a climate change model
  - removing details that are not relevant to the problem
- What details about a queue are irrelevant to figuring out how many tills are needed in a new store?





# Another queueing problem

- Suppose you are trying to find a solution to the problem of bottlenecks at toll booths on a motorway
- What factors would be relevant, and what would be irrelevant?



# Abstraction and reality

- Abstraction is an important tool in problem-solving
- All the details that do not contribute to the essential characteristics of the problem are omitted
- The **London Underground map** is a good example of information hiding
  - Can you think of others?



# A robot vacuum cleaner... this?



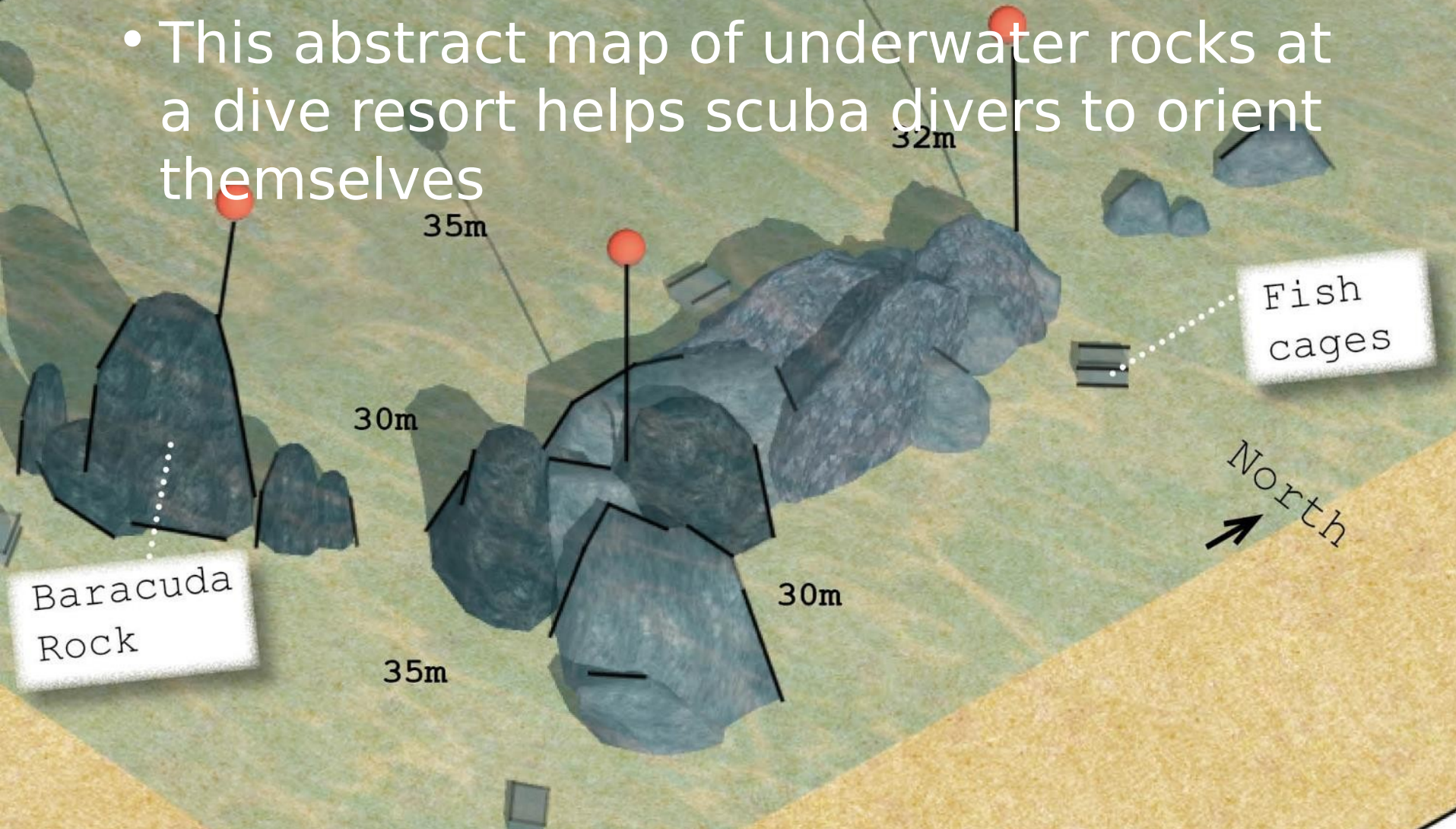
# ... or this?





# Scuba diving map

- This abstract map of underwater rocks at a dive resort helps scuba divers to orient themselves



# Problem abstraction

- This involves removing details until the problem reduces to one which has already been solved
- What do maps of a town, of the ocean floor, of a country, have in common?
- What do fingerprint recognition, iris scanning, footprint scanning, text recognition, number plate recognition, have in common?





# Modelling and simulation

- Building a model of a real world object or phenomenon may be used to help solve a particular problem
- Computer scientists have to decide what details are relevant to the problem and discard everything else
- Algorithms and data structures can then be designed to solve the problem
- The algorithm is then implemented in program code and executed



# Models of real-world problems

A financial model which calculates the likely profit from a coffee shop, based on the

.. . . .





# Models of real-world problems

A climate change model which predicts the consequences of a 2°C rise in temperature



# Models of real-world problems

An aircraft simulator which can be used to train pilots



# Worksheet 1

- Now try **Task 1** on the worksheet



# Plenary

- Abstraction in its many forms is a fundamental concept used in computational thinking and problem solving
- Removing irrelevant details allows the computer scientist to focus on the essence of a problem



# Worksheet 1

- Now try **Task 2** on the worksheet



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